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ABSTRACT

A total of 2,052 US high school boys and girls, selected from 10 geographical regions, were tested on consecutive half days using the Armed Services Vocational Aptitude Battery (ASVAB) Form 2 and ASVAB Form 5. Effects of fatigue, training, environment and proctorial variation were minimized by experimental design. An extensive program of optical scanning, computer analysis, intertest comparisons, correlation matrix generation, factor analysis, and equipercentile calculations was conducted. Four factors were identified, with three of the new subtests in the larger battery (ASVAB Form 5) found to be vocationally oriented as opposed to scholastically oriented. Seven subjects common to both batteries had reliability coefficients ranging from 0.56 to 0.76. A new factor in vocational testing, tentatively described as "attention to explicit rules," was identified. (Author)

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TECHNICAL RESEARCH REPORT 76-4

ASVAB

ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) CORRELATIONAL ANALYSIS, ASVAB FORM 2 VERSUS ASVAB FORM 5

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DECEMBER 1976

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A total of 2,052 US high school boys and girls, selected from 10 geographical regions, were tested on consecutive half days using the Armed Services Vocational Aptitude Battery (ASVAB) Form 2 and ASVAB Form 5. Effects of fatigue, training, environment and proctorial variation were minimized by experimental design. An extensive program of optical scanning, computer analysis, intertest comparisons, correlation matrix generation, factor analysis, and equipercentile calculations was conducted. Four factors were

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PREFACE

This report was submitted by Rothe Developments, Incorporated, San Antonio, Texas under contract F41609-76-C-006, and executed by St. Mary's University Research Center, San Antonio. Mr. W. E. Rothe was project manager. Dr. John Fletcher was project director and principal investigator. Dr. Tom Mote directed the computer analysis program, assisted by Mr. Neil Kammer and personnel of the University Computing Center (Director: Mr. Terry Vetters). The work was accomplished between September 1975 and May 1976 under the contract monitorship of Dr. Malcolm J. Ree, Personnel Research Division, Air Force Human Resources Laboratory, Lackland Air Force Base, Texas.

This MEPCOM Technical Research Report was extracted from AFHRL Technical Report 76-70, Lackland Air Force Base, Texas, October 1976. All data contained in the original study report are reprinted here, *except* for the equipercentile conversion tables broken down by subtest, grade and sex. High school counselors requiring the conversion tables are referred to AFHRL Technical Report 76-70 or to MEPCOM Technical Research Report 76-5 (December 1976).

Grateful recognition is extended to members and faculty of St. Mary's University Graduate School and 28 public and private high schools (listed in Appendix A) for their professional participation in this experimental project. The national sampling plan was executed by Dr. James Ritter. University Research Center activities were directed and coordinated by Dr. George A. Benz.

SUMMARY

A total of 2,052 U.S. high school boys and girls, selected from 10 geographical regions, were tested on consecutive half days using the Armed Services Vocational Aptitude Battery (ASVAB) Form 2 and Form 5. An extensive program of optical scanning, computer analysis, intertest comparisons, correlation matrix generation, factor analysis, and equipercentile calculations was conducted. Four factors were identified, with three of the new subtests in the larger battery (ASVAB Form 5) found to be vocationally oriented as opposed to scholastically oriented. Seven subtests common to both batteries had reliability coefficients ranging from 0.56 to 0.76. A new factor in vocational testing, tentatively described as "attention to explicit rules," was identified.

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ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) CORRELATIONAL ANALYSIS, ASVAB FORM 2 VERSUS ASVAB FORM 5

I. INTRODUCTION

The selection of an appropriate test battery is based on its content and applicability to the vocational trainee population. This report describes the testing of a national sample of U.S. high school students with (a) an established version of Armed Services Vocational Aptitude Battery (ASVAB), and (b) a new, enlarged version of the same test battery.

The purpose of the study was to generate correlation matrices and conversion tables equating components of the old form of the battery with scales and components in the new version. The purpose of this report is to describe the research methodology and findings, and to compare and contrast the two test measures. Additionally, correlation and factor analyses were executed which showed four component factors. These are described and used to identify the vocational aptitude contents of the two batteries.

II. METHOD

Two paper and pencil vocational aptitude tests were presented on consecutive half days to a sample of U.S. high school students in grades 10 through 12 using a counterbalanced plan, and identical test administration conditions in each school.

The first test battery, designated ASVAB Form 2, consists of 5 practice and 300 test questions grouped into 9 subtests. Form 2 has been in nationwide use in school years 1973-74, 1974-75, and 1975-76, and has been completed by over 3.6 million students. The second test battery, designated ASVAB Form 5, consists of 5 practice and 295 test questions grouped into 12 subtests. Seven subtests of slightly different size and duration are common to Forms 2 and 5. These range from Word Knowledge to Space Perception, and from Mechanical Comprehension to Automotive, Electronics, and Shop Information.

Table 1 and Appendix D describe the administration, contents, composites, scoring, and types of questions in both vocational aptitude batteries used (ASVAB 2; ASVAB 5). Bayroff and Fuchs (1970) describe the development of ASVAB 1 from earlier military tests used in the USA. General and High School Counselors' Manuals (U.S. Department of Defense, 1972; 1973; 1974) give full details of the contents and applications of ASVAB 2. Wilfong and Armstrong (1974) give statistical tables for national, regional and grade scores achieved in high schools, using ASVAB 2.

High School Sample

Figure 1 shows the nationwide distribution of participating high schools and students.

Three hundred forty-three public and private high schools (1.25% of U.S. total) were invited to participate in vocational testing of their students. Twenty-eight schools (26 public and 2 private; 0.10% of U.S. total) wished to participate and were able to schedule Form 2 and Form 5 testing on successive days in the period from November 1975 to March 1976. Three thousand seventy students (6.00% of enrollment) voluntarily participated, and two thousand fifty-two (4.01% of enrollment) completed both Form 2 and Form 5 tests (907 in sequence Form 2, then 5; 1,145 in sequence Form 5, then 2). The nationwide distribution of schools and students included all four Federal planning regions as used by Government departments for statistical reporting, and all nine geographical areas, plus the Washington, D.C. Standard Metropolitan Statistical Area (SMSA), making a total of 10 regions. Testing took place in 21 urban, four suburban, and three rural schools in

13 single county and multiple county standard metropolitan statistical areas as defined by U.S. Bureau of Census (1970) and U.S. Department of Commerce (1975). Large, medium-sized, and small public (26) and private (2) schools took part, with enrollments in the range of 85 to 4,472 (mean = 1,828; 1973 national average = 742). Approximately equal numbers of grade 10, 11, and 12 males and females were tested, as shown in the small insert on Figure 1. Test answer sheets and records were handled confidentially according to the Privacy Act (PL 93-579).

The school/student sample is a geographically stratified selection of schools interested in vocational testing, in numbers approximately proportional to the national mixture of public versus private, and urban versus suburban versus rural schools. It is not regarded as a random representation because the 2,052 students tested were volunteers, and because neither they nor their schools represented all strata of the nationwide high school population. The national distribution is given by Gertler (1974), Gertler and Barker (1971, 1973). Descriptions of schools and statistics of enrollment were obtained from the national directory compiled by the U.S. Department of Health, Education, and Welfare (1974), and the roster of schools participating in ASVAB testing. National, Federal planning region, and geographical area statistics on high school student subpopulations were from Grant and Line (1973), and U.S. Department of Commerce (1975).

Consecutive Half Day Testing

Test administration conditions were identical within each school for the presentation of Form 2 and Form 5 on two consecutive days. For reasons of maximum comparability (Flanagan, 1951, pp. 752-3) tests were scheduled at the same time and in the same rooms on either two consecutive mornings or two consecutive afternoons. Approximately 1,000 students were unable to complete both tests on consecutive days, and were excluded from data analysis. Matched pairs of optical scan answer sheets for Form 2 and Form 5 were obtained from the residual 2,052 students.

Test sessions were conducted by trained university faculty or education/psychology graduates and trained military testers. Proctors were members of the high school faculty, counseling faculty, or graduate students in education or psychology. Many had prior experience as test administrators or researchers. Adherence to ASVAB test administration guidelines and instructions was maintained. These call for disclosure of individual subtests in Form 5 only as soon as all candidates have completed each section.

TABLE 1

ADMINISTRATION AND CONTENTS OF VOCATIONAL TESTS

(A) ADMINISTRATION

Abbreviated Name	ASVAB 2	ASVAB 5
Total Time (minutes)	142	165
Instructions & Administration	30	30
Aggregate Testing Time	112	135
Number of Sections	9	12
Number of Questions	305	300
Practice Questions	5	5
Test Questions	300	295
Test Booklet (8 x 10½ in. pages)		
Columns Per Page	1-2	1-2
Test Section Pages	54	57
Optical Scanning Answer Sheets (sides)	3	3
Number of Schools (students) tested	28(2052)	28(2052)
Testing Period (consecutive half days)	November 1975-March 1976	

(B) CONTENTS (QUESTIONS; (MINUTES))

Subtest and Abbreviation	ASVAB 2	ASVAB 5
Coding Speed (CS)	100(7)	—
General Information (GI)	—	15(7)
Numerical Operations (NO)	—	50(3)
Attention to Detail (AD)	—	30(5)
Word Knowledge (WK)	25(10)	30(10)
Mathematics Knowledge (MK)	—	20(20)
Arithmetic Reasoning (AR)	25(25)	20(20)
Tool Knowledge (TK)	25(10)	—
Space Perception (SP)	25(15)	20(12)
Mechanical Comprehension (MC)	25(15)	20(15)
General Science (GS)	—	20(10)
Shop Information (SI)	25(10)	20(8)
Automotive Information (AI)	25(10)	20(10)
Electronics Information (EI)	25(10)	30(15)

TABLE 1 (con't)

(C) COMPOSITES

Name and Abbreviation of Composite	Form 2 Formula and Max. Score	Form 5 Formula and Max. Score
Electronic/Electrical (EL)	MC + 2 EI 75	AR + EI 50
General Mechanical (GM)	SP + 2 SI 75	SP + SI + AR 60
Clerical Administrative (CL)	WK + 1/3 CS 58	WK + AD + NO 110
General Technical (GT)	AR + WK 50	AR + WK 50
Motor Mechanical (MM)	MC+ 2 AI 75	MC + AI + MK 60

(D) SCORING AND REPORTING

Correction for Guessing:	Rights — 1/3 Wrongs (Except CS)	No Corrections Applied
Reported to School as:	Percentiles for Same Grade & Sex	Percentages of Maximum Attainable Score
Equipercentiles:	(I) Each Grade and Sex reported separately, (II) Pooled (n = 2052)	

III. RESULTS

Descriptive Scoring Statistics

Table 2 presents the means and standard deviations for each subtest and composite for both ASVAB forms by sex and grade level.

Visual inspection of Table 2 shows that subgroup mean scores were higher for grade 11 than for grades 10 and 12 in both sexes and in all tests. Females scored better than or equal to males in Coding Speed (CS) and Attention to Detail (AD). Males scored substantially better than females in Tool Knowledge (TK), Mechanical Comprehension (MC), Shop Information (SI), Automotive Information (AI), and Electronics Information (EI). In Numerical Operations (NO), grade 10 females outperformed grade 10 males. Sixty-three to 66% of maximal possible scores were obtained by grade 11 males in Numerical Operations (NO), Mathematics Knowledge (MK), and General Information (GI), whereas only 47-50% of maximum was achieved in Coding Speed (CS) and Automotive Information (AI-Form 5).

Form 2 Versus Form 5 Correlation Analysis

Pearson product-moment correlations were computed for each subsample and the total sample. Seven 21 x 21 matrices were computed. Each matrix contained data for nine tests from Form 2 and 12 tests from Form 5. One correlation matrix for the total sample population (N = 2,052) is given in Table 3.

In the total sample, results show a wide range of correlations, with two subtests (Word Knowledge, WK; Arithmetic Reasoning, AR) showing similarity between the two forms, and test scores for letter-number manipulation (CS, AD, NO) unrelated to test scores for job and technical knowledge (TK, SI, AI). The five highest cross-correlations were between the two WK subtests (.760); the two AR subtests (.725); MK, Form 5 versus AR, Form 2 (.705); MC versus Electronics Information (EI), Form 5 (.704); and TK versus SI, Form 2 (.701). The lowest cross-correlations were CS versus TK, Form 2 (.010); AD, Form 5 versus SI, Form 2 (.035); AD, Form 5 versus AI, Form 2 (.052); AD versus AI, Form 5 (.055); and NO, Form 5 versus TK, Form 2 (.065).

Sex differences were seen in different grade level subgroups between SI and TK subtests, Form 2; CS and TK subtests, Form 2; EI and MC subtests, Form 5; and AI, Form 2 and AD, Form 5. Male performance was better on SI, TK, AI, Form 2; EI and MC on Form 5. Females exceeded males on CS, Form 2; and AD, Form 5.

Comparisons among the correlation matrices showed considerable variation by grade within such correlations as NO, Form 5 versus TK, Form 2.

TABLE 2

DESCRIPTIVE SCORING STATISTICS: MEANS & STANDARD DEVIATIONS

	GRADE 10 MALES (N = 257)		GRADE 10 FEMALES (N = 334)		GRADE 11 MALES (N = 374)		GRADE 11 FEMALES (N = 500)	
Form 2 Tests	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
AR	10.32	6.065	8.87	5.286	13.19	5.896	10.87	5.420
EI	10.56	5.314	6.20	4.016	12.99	5.040	7.09	4.406
SP	13.43	6.257	11.75	5.296	15.36	5.498	13.19	5.783
AI	11.35	5.010	7.60	3.802	13.28	4.816	8.30	3.765
MC	11.33	5.321	8.16	3.891	13.80	4.657	9.71	4.265
SI	11.95	4.823	6.69	3.858	13.63	5.082	8.04	3.929
WK	11.04	5.180	10.31	5.011	13.50	4.960	12.19	5.166
CS	39.44	13.092	45.36	13.283	47.12	12.940	51.64	12.959
TK	12.24	5.013	5.48	3.542	14.11	5.539	6.62	4.452
Form 2 Composites								
EL	32.46	14.458	20.56	9.908	39.79	13.493	23.90	11.326
GM	37.32	13.741	25.13	10.595	42.62	13.146	29.27	11.432
CL	24.21	7.924	25.42	7.752	29.20	7.250	29.42	7.670
GT	21.35	10.122	19.18	9.251	26.70	9.783	23.06	9.266
MM	34.04	13.615	23.37	9.522	40.36	12.613	26.31	9.734
Form 5 Tests								
AR	10.05	4.023	8.98	3.159	12.29	4.047	10.37	3.597
EI	14.45	5.698	11.94	3.543	17.60	6.037	12.90	4.119
SP	10.30	4.216	9.16	3.335	11.61	4.134	10.10	3.735
AI	8.12	4.414	5.46	2.660	9.87	4.880	6.13	2.687
MC	9.19	4.264	6.33	2.828	10.68	4.477	7.06	3.170
SI	10.35	4.694	7.36	3.167	12.11	4.636	8.63	3.336
WK	14.95	6.325	13.41	5.694	18.43	6.278	16.55	6.213
AD	13.04	3.935	14.19	4.226	15.94	4.961	16.02	4.732
NO	24.93	10.647	26.97	10.268	33.14	10.527	33.08	10.870
MK	10.91	4.729	10.27	4.334	12.92	4.956	11.95	4.717
GS	9.09	4.219	7.72	3.465	10.98	4.628	9.14	3.642
GI	8.55	2.766	6.76	1.982	9.58	2.473	7.40	2.024
Form 5 Composites								
EI	24.50	8.607	20.92	5.524	29.89	8.873	23.27	6.611
GM	30.70	10.400	25.49	6.894	36.02	9.957	29.09	8.161
CL	52.92	16.372	54.57	15.196	67.50	16.978	65.64	17.138
GT	25.00	9.340	22.39	7.871	30.71	9.335	26.92	8.814
MM	28.21	11.122	22.05	7.151	33.47	11.422	25.15	8.183

TABLE 2 (con't)
DESCRIPTIVE SCORING STATISTICS: MEANS & STANDARD DEVIATIONS

	GRADE 12 MALES (N = 281)		GRADE 12 FEMALES (N = 306)		GRADE 10-12 BOTH SEXES (N = 2052)	
Form 2 Tests	MEAN	S.D.	MEAN	S.D.	MEAN	S.D.
AR	12.39	5.898	9.84	5.484	10.95	5.834
EI	12.87	5.876	6.47	4.240	9.16	5.593
SP	14.37	5.960	12.45	5.354	13.43	5.804
AI	12.91	4.660	7.76	4.207	10.03	4.952
MC	12.83	5.259	9.14	4.351	10.75	5.007
SI	13.34	5.029	7.24	3.971	9.94	5.279
WK	12.96	4.865	12.01	5.001	12.06	5.151
CS	44.92	13.394	50.45	12.848	47.17	13.637
TK	13.53	5.469	5.77	4.003	9.32	5.986
Form 2 Composites						
EL	38.57	15.640	22.09	11.012	29.06	14.781
GM	41.05	14.090	26.93	11.572	33.30	14.119
CL	27.91	7.700	28.87	7.617	27.79	7.876
GT	25.35	9.516	21.85	9.180	23.01	9.811
MM	38.65	12.899	24.66	10.709	30.80	13.261
Form 5 Tests						
AR	11.57	4.441	9.87	3.552	10.54	3.947
EI	16.39	6.621	11.90	3.775	14.12	5.460
SP	10.96	4.396	9.61	3.672	10.29	3.985
AI	8.97	4.978	5.50	2.614	7.25	4.140
MC	9.40	4.641	6.32	2.783	8.08	4.077
SI	11.00	5.022	7.66	3.317	9.45	4.381
WK	17.89	6.597	15.72	6.227	16.24	6.437
AD	14.05	4.674	14.81	4.074	14.88	4.622
NO	30.44	10.740	29.89	9.741	30.24	10.912
MK	11.99	4.930	10.94	4.607	11.58	4.799
GS	9.69	4.456	8.17	3.433	9.17	4.114
GI	9.17	2.514	6.99	2.287	8.02	2.554
Form 5 Composites						
EI	27.96	9.574	21.77	6.144	24.67	8.240
GM	33.53	10.997	27.14	8.297	30.29	9.768
CL	62.39	17.202	60.41	14.860	61.36	17.226
GT	29.46	9.846	25.59	8.976	26.78	9.416
MM	30.36	12.096	22.77	7.865	26.90	10.488

Factor Analysis

Factor analysis of the correlation matrix presented in Table 3 was performed using a principal axis and Varimax solution (Thurstone, 1950; Kaiser, 1958). The final analysis yielded four factors which accounted for 68.9% of the variance. Tentative solutions, yielding five and six factors, accounted for 72.6% and 75.5% of the variance respectively, but did not lead to improvement in the factor structure.

Selection of the Varimax rotation method (Harman, 1960, p. 301) has the effect of simplifying columns within the factor loading matrix, thus emphasizing structural simplicity.

Table 4 shows the results of the final analysis. It lists factor loadings for all 21 subtests in the upper half. Eight entries in the range 0.40 to 0.53 are listed in the lower half. The seven subtests which are common to ASVAB Form 2 and ASVAB Form 5 (AR, EI, SP, AI, MC, SI, WK) are clearly paired in the factor structure. The factorial relationships of the other seven subtests (CS & TK in Form 2; AD, NO, MK, GS, & GI in Form 5) appear to be reasonably consistent. The four defined factors are:

Factor 1: Clearly associated with subtests measuring non-scholastic job or hobby related knowledge. High factor scores may be predictive of success in skill training and/or technical vocation. Tentatively identified as *"technical information."*

Factor 2: Strongly associated with scholastically oriented subtests. Incapable of being resolved into classical independent verbal and quantitative components, even in 5-factor, 6-factor and 7-factor solutions. Identified as *"scholastic information."*

Factor 3: Contains loadings of 0.40 or more on only three subtests, two of which are speeded tests. All three subtests require careful *"attention to explicit rules."*

Factor 4: Clearly associated with *"spatial perception"* capability, and should be identified with that title. Includes ability to interpret diagrams not labeled with words.

Equipercentile Tables (See MEPCOM Technical Research Report 76-5)

Percentiles are the sets of values which divide a total frequency distribution into 100 equal parts. Equipercentiles are sets of values for two or more frequency distributions which are either equivalent or have been measured using different metrics on the same sample (Flanagan, 1951, pp. 752-6; Lindsay and Prichard, 1971).

The equipercentile computer program for equating ASVAB Form 2 and Form 5 establishes a relationship from raw score on Form 2 to raw score on Form 5 through the medium of a common percentile scale. The fitting of the curve to the observed scores, which is usually done by hand and eye, was accomplished by a least-squares regression procedure (Lindsay and Prichard, 1971).

Equipercentile tables were produced for all seven subtests and for all five composites, resulting in 49 equipercentile tables for the former and 35 tables for the composites. School counselors, vocational specialists, and human resource researchers can use them to determine the Form 5 raw score and percentile equivalents to any given Form 2 raw score or percentile. Thus, scores for Form 5 may be equated to scores on Form 2.

Due to the very size of the equipercentile conversion tables, they are not appended to this Research Note. Interested readers are referred to AFHRL Technical Report 76-70, Lackland Air Force Base, Texas (October 1976), or MEPCOM Technical Research Report 76-5 (December 1976).

TABLE 3

MATRIX OF INTERTEST CORRELATIONS (N = 2052)

	FORM 2									FORM 5												
Form 2	AR	EI	SP	AI	MC	SI	WK	CS	TK	AR	EI	SP	AI	MC	SI	WK	AD	NO	MK	GS	GI	Form 2
AR	1.000	0.460	0.564	0.365	0.594	0.389	0.594	0.365	0.317	0.725	0.478	0.487	0.378	0.502	0.408	0.635	0.184	0.433	0.704	0.509	0.445	AR
EI	0.460	1.000	0.461	0.622	0.609	0.647	0.419	0.115	0.613	0.438	0.619	0.399	0.538	0.578	0.561	0.456	0.071	0.177	0.405	0.484	0.498	EI
SP	0.564	0.461	1.000	0.380	0.633	0.442	0.437	0.284	0.422	0.518	0.445	0.677	0.350	0.523	0.387	0.477	0.147	0.250	0.535	0.446	0.327	SP
AI	0.365	0.622	0.380	1.000	0.531	0.647	0.301	0.090	0.623	0.351	0.482	0.310	0.564	0.489	0.516	0.318	0.052	0.121	0.289	0.374	0.420	AI
MC	0.594	0.609	0.633	0.531	1.000	0.599	0.535	0.233	0.538	0.548	0.583	0.547	0.494	0.642	0.514	0.561	0.141	0.262	0.531	0.533	0.474	MC
SI	0.389	0.647	0.442	0.647	0.599	1.000	0.377	0.061	0.701	0.384	0.545	0.378	0.571	0.553	0.584	0.383	0.035	0.117	0.307	0.405	0.478	SI
WK	0.594	0.419	0.437	0.301	0.533	0.377	1.000	0.316	0.253	0.531	0.492	0.381	0.356	0.453	0.428	0.760	0.137	0.364	0.571	0.550	0.459	WK
CS	0.365	0.115	0.284	0.090	0.233	0.061	0.316	1.000	0.010	0.343	0.221	0.263	0.085	0.148	0.161	0.352	0.417	0.579	0.417	0.221	0.178	CS
TK	0.317	0.613	0.422	0.625	0.558	0.701	0.253	0.010	1.000	0.323	0.518	0.351	0.566	0.647	0.564	0.289	0.064	0.065	0.240	0.377	0.449	TK
Form 5																						Form 5
AR	0.725	0.438	0.518	0.351	0.548	0.384	0.531	0.343	0.333	1.000	0.522	0.508	0.399	0.539	0.446	0.623	0.224	0.434	0.704	0.510	0.470	AR
EI	0.478	0.619	0.445	0.482	0.588	0.545	0.492	0.221	0.518	0.522	1.000	0.458	0.616	0.704	0.661	0.561	0.147	0.279	0.487	0.639	0.527	EI
SP	0.487	0.399	0.677	0.310	0.547	0.378	0.381	0.263	0.351	0.508	0.458	1.000	0.339	0.523	0.383	0.436	0.202	0.315	0.525	0.480	0.337	SP
AI	0.378	0.538	0.350	0.564	0.494	0.571	0.356	0.085	0.566	0.399	0.616	0.339	1.000	0.617	0.691	0.371	0.055	0.151	0.324	0.556	0.465	AI
MC	0.502	0.578	0.523	0.489	0.642	0.553	0.453	0.148	0.547	0.539	0.704	0.525	0.617	1.000	0.638	0.514	0.116	0.224	0.499	0.625	0.512	MC
SI	0.408	0.561	0.387	0.516	0.514	0.584	0.428	0.161	0.564	0.446	0.661	0.383	0.691	0.638	1.000	0.461	0.107	0.258	0.402	0.598	0.502	SI
WK	0.635	0.456	0.477	0.318	0.561	0.383	0.760	0.352	0.289	0.623	0.561	0.456	0.371	0.514	0.461	1.000	0.184	0.412	0.638	0.633	0.517	WK
AD	0.184	0.071	0.147	0.052	0.141	0.035	0.137	0.417	0.064	0.224	0.147	0.202	0.035	0.116	0.107	0.184	1.000	0.455	0.224	0.110	0.136	AD
NO	0.433	0.177	0.250	0.121	0.262	0.117	0.364	0.579	0.065	0.434	0.279	0.315	0.151	0.224	0.258	0.412	0.455	1.000	0.502	0.270	0.276	NO
MK	0.703	0.405	0.535	0.289	0.531	0.307	0.571	0.417	0.240	0.704	0.487	0.525	0.324	0.499	0.402	0.638	0.224	0.502	1.000	0.544	0.430	MK
GS	0.509	0.484	0.466	0.374	0.533	0.405	0.550	0.221	0.377	0.530	0.639	0.430	0.555	0.625	0.598	0.633	0.118	0.270	0.544	1.000	0.488	GS
GI	0.445	0.498	0.327	0.420	0.474	0.478	0.459	0.178	0.449	0.470	0.527	0.337	0.465	0.512	0.502	0.517	0.136	0.276	0.430	0.488	1.000	GI

TABLE 4

RESULTS OF FACTOR ANALYSIS: FACTOR LOADINGS FOR 21 TESTS

FACTOR 1 (9 Subtests) Technical Information and Related Knowledge		FACTOR 2 (6 Subtests) Scholastic Information: Involves Both Verbal and Quantitative Knowledge		FACTOR 3 (3 Subtests) Attention to Explicit Rules: Includes Ability to Work at Speed		FACTOR 4 (3 Subtests) Spatial Perception: Includes Ability to Interpret Vectorial Diagrams	
TK2	0.818	WK5	0.793	AD5	0.826	SP2	0.791
SI2	0.785	WK2	0.763	NO5	0.757	SP5	0.721
AI5	0.768	GS5	0.681	CS2	0.743	MC2	0.540
AI2	0.762	MK5	0.664				
SI5	0.735	AR2	0.620				
EI2	0.712	AR5	0.614				
EI5	0.647						
MC5	0.629						
GI5	0.530						
Other loadings in range 0.40 to 0.53							
MC2	0.530	EI5	0.491	None		AR2	0.482
GS5	0.447	GI5	0.485			MK5	0.435
		MC5	0.433			AR5	0.416

Note: All 9 Form 2 subtests and all 12 Form 5 subtests appear only once in upper half of table.

IV. INTEPRETATION AND DISCUSSION

ASVAB Forms 1, 2, and 5

Approximately 3.646 million students have taken part in the Armed Forces High School Testing Program during school years 1973-76, using ASVAB Form 2. Approximately 2.549 million students, in school years 1968-73, were administered ASVAB Form 1. A cross-comparison of ASVAB Form 1 and ASVAB 2 results was made (Wilfong, Armstrong, and Huckell; 1974) for 873,628 and 711,031 students, respectively. Comparison of Form 2 results for 2,052 students in the present study and 771,031 students in school year 1973-74 shows comparable or slightly lower group average scores for individual tests in the smaller group, similar standard deviations for every test, identical patterns of male-female score differences, and grade 11 superiority over grade 12 scores in 5 of 8 subsamples (N = 771,031) compared with 18 of 18 subsamples (N = 2,052). Accordingly, test scores on Form 2 were reported to students and their counselors as raw scores and percentiles computed for their grade and sex. Form 5 test scores were reported as raw scores and percent of maximum test score.

Interbattery comparison between Form 1, Form 2, and Form 5 shows that Forms 1 and 2 differed in their difficulty level, but not in their test structure or content, while Forms 2 and 5 differed in structure and content. In constructing ASVAB Form 2, tests AR, EI, SP, AI and MC were reduced in difficulty, CS was unchanged, and WK was made more difficult (Wilfong, Armstrong, and Huckell, 1974). In developing ASVAB Form 5 from ASVAB Form 2, tests CS and TK were eliminated, tests AR, SP, MC, SI and AI were reduced in length, tests WK and EI were increased in length, and five new tests were added — GI, NO, AD, MK, and GS.

Reliability

Reliability is defined as the property of a test to produce consistent scores from one administration to another (Thorndike, 1971, p. 357). The lack of consistency in a set of measurements made repeatedly on a sample may be expressed as intraindividual variance, and the standard error of measurement is its positive square root. When two equivalent measures are obtained for each individual, a correlation coefficient between the data sets provides one form of reliability coefficient.

Table 3 presents intertest correlations for ASVAB Forms 2 and 5. It shows, in particular, that the Form 2 and Form 5 variants of WK and AR have relatively high correlation coefficients. All correlational values for the total sample are in the range 0.56-0.76.

Validity

The validity of a test or of a test battery is the property which makes it useful for a specified purpose. There is no single validity for a test or test battery but rather a validity for each application. The job-related and hobby-related nature of TK Form 2, SI Forms 2 and 5, AI Forms 2 and 5, MC Form 5 and GI Form 5 in Factor 1, and their clear separation in the factor analysis from Factors 2-4 (scholastic information, attention to explicit rules, and spatial perception) can be interpreted as evidence that both ASVAB Form 2 and Form 5 are valid instruments for testing for vocational technical information in high school students. Factors 2-4 are possible predictors of more general capabilities: (1) ability to read, understand, and respond to questions, (2) ability to work according to directions, and (3) ability to perceive and respond to visual displays and questions; e.g., mechanical drawings.

The uses of ASVAB Forms 1 and 2 for predicting secondary school success, technical school success, high school vocational-technical course success, and civilian vocational-technical school completion have been examined and assessed by Harris and Huckell (1974), Vitola, Mullins, and Croll (1973), Bower, Lewis, and Krockover (1975), and Jensen and Valentine (1976). There is good evidence of correlation between ASVAB scores and suitability for vocational-technical training, although much variation exists between technical specialties and between individual students. Further work is required to establish whether relationships exist between test scores and long term job success.

V. CONCLUSIONS

Suitably designed vocational aptitude tests appear, from these results, to clearly distinguish nonscholastic, technical knowledge from scholastic information in high school boys and girls. By testing 2,052 high school students selected from all regions of the continental U.S. and from small, medium, and large public and private schools, a wide range of test scores was obtained on a nine-test and on a twelve-test battery. By arranging for standardized test administration and instructions, with all students present on two consecutive half days, and by using a counterbalanced sequencing plan, the possible effects of fatigue or training, and of unwanted environmental effects were minimized. An extensive program of optical scanning and computer analysis of scores led to intertest comparisons, correlation and factor analyses, and a set of equipercentile tables equating the common tests in both batteries.

The twelve-subtest battery contains four new subtests, three of which are found to be vocationally oriented. Seven subtests common to both batteries produced scores with reliability coefficients in the range of 0.56-0.76. A new factor — tentatively identified as "attention to explicit rules" — had the highest single factor loading of 21 tests. No evidence was found that this factor had been clearly identified by earlier workers, although "carefulness" and "perceptual speed" were second-order or third-order factors detected during the testing of World War II aviation cadets (Cronbach, 1960).

Content analysis suggests that Form 5 of ASVAB is an effective instrument for testing technical ability, academic ability, spatial perception, and attention to explicit rules in high school males and females. The new battery covers a wider topical range than Form 2 of ASVAB by adding General Science, Mathematics Knowledge, Numerical Operations and General Information.

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APPENDIX A

PARTICIPATING U.S. HIGH SCHOOLS RANKED BY SIZE OF ENROLLMENT

NAME	STATE	ENROLLMENT	STUDENTS TESTED*
Philadelphia: Olney H.S.	PA	4,472	26
Miami: Carol City H.S.	FL	3,947	59
Pittsburgh: North Hills H.S.	PA	3,276	47
Trenton: Central H.S.	NJ	3,001	21
Detroit: Ford H.S.	MI	2,937	43
Los Angeles: Belmont H.S.	CA	2,915	37
Denver: Lincoln H.S.	CO	2,722	62
Los Angeles: Alexander Hamilton H.S.	CA	2,395	41
Detroit: M. L. King H.S.	MI	2,237	38
Miami: Northwestern H.S.	FL	2,141	54
Washington, D.C.: Eastern H.S.	DC	2,129	84
El Toro H.S.	CA	1,890	91
Bear Creek H.S.	CO	1,875	11
Philadelphia: Mastbaum Voc. Tech.	PA	1,658	25
Philadelphia: Kensington H.S.	PA	1,656	29
Farmington H.S.	MI	1,636	93
Bartlett H.S.	TN	1,629	238
Pawtucket H.S.	RI	1,445	29
Kansas City: Paseo H.S.	MO	1,409	112
Kansas City: Manuel H.S.	MO	1,388	118
Kansas City: Lincoln H.S.	MO	1,316	150
Washington, D.C.: Springart H.S.	DC	1,192	23
Boston H.S.	MA	636	98
San Antonio: South Side H.S.	TX	600	119
San Antonio: St. Francis Academy	TX	278	174
San Antonio: SANYO	TX	172	76
LaVernia H.S.	TX	160	99
Greater Miami Academy	FL	85	55

*Numbers listed are for those completing both ASVAB Form 2 and Form 5.

APPENDIX B

SHORT DESCRIPTIONS OF TESTS

ASVAB FORM 2

TESTS IN THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB)

1. Coding Speed test (CS). In this test there is a key and 100 items. The key is a group of words with a code number for each word. Each item presents one word for which the examinee indicates the code number.

2. Word Knowledge (WK). Each item requires the examinee to select the correct synonym for a specific word.

3. Arithmetic Reasoning (AR). Each item is a reasoning problem involving application of an arithmetic process.

4. Tool Knowledge (TK). Each item presents five drawings of various tools or shop equipment. The examinee indicates which of the four alternative drawings goes best with the lead drawing.

5. Space Perception (SP). Each item consists of five drawings: a pattern and four boxes. The question to be answered is which one of the boxes can be made by folding the pattern.

6. Automotive Information (AI). Each item asks a question about the identification or operation of automobile parts.

7. Shop Information (SI). This test has questions about shop practices and the use of tools. Many of the items contain drawings.

8. Mechanical Comprehension (MC). Each item includes a drawing, or drawings, illustrating some physical principle and a question.

9. Electronics Information (EI). This test has questions about elementary principles of electricity and about electrical/electronic devices, drawings, and equipment.

12 SUBTESTS IN ASVAB FORM 5

1. **Arithmetic Reasoning (AR)**
   Multiple choice questions about everyday arithmetic problems and reasoning processes, including prices, salaries, premiums, ages, and schoolwork.

2. **Electronics Information (EI)**
   Multiple choice questions about elementary principles of electricity and about electrical/electronic devices, drawings and equipment used in everyday life.

3. **Space Perception (SP)**
   Ability test requiring the 3 dimension potential examination of five drawings: a pattern and four boxes. The question to be answered is which one of the boxes can be made by folding the pattern.

4. **Automotive Information (AI)**
   Multiple choice questions about parts of automobiles, their operation, and when repairs are needed. Requires some understanding of technical terms and names of components.

5. **Mechanical Comprehension (MC)**
   Multiple choice items, mostly including diagrams, which serve to illustrate the physical principles by which well-known devices and structures operate.

6. **Shop Information (SI)**
   Multiple choice items about tools, repairs, maintenance and common workshop tasks.

7. **Word Knowledge (WK)**
   Multiple choice questions requiring the selection of words having the same meaning and sense as a given single noun, verb, adjective or adverb.

8. **Attention to Detail (AD)**
   Speed test of ability to find an important detail in 30 similar letter layouts.

9. **Numerical Operations (NO)**
   Speed and accuracy test using 50 simple multiple choice questions in arithmetic.

10. **Mathematics Knowledge (MK)**
    Multiple choice questions on general mathematics problems including simple algebra and geometry.

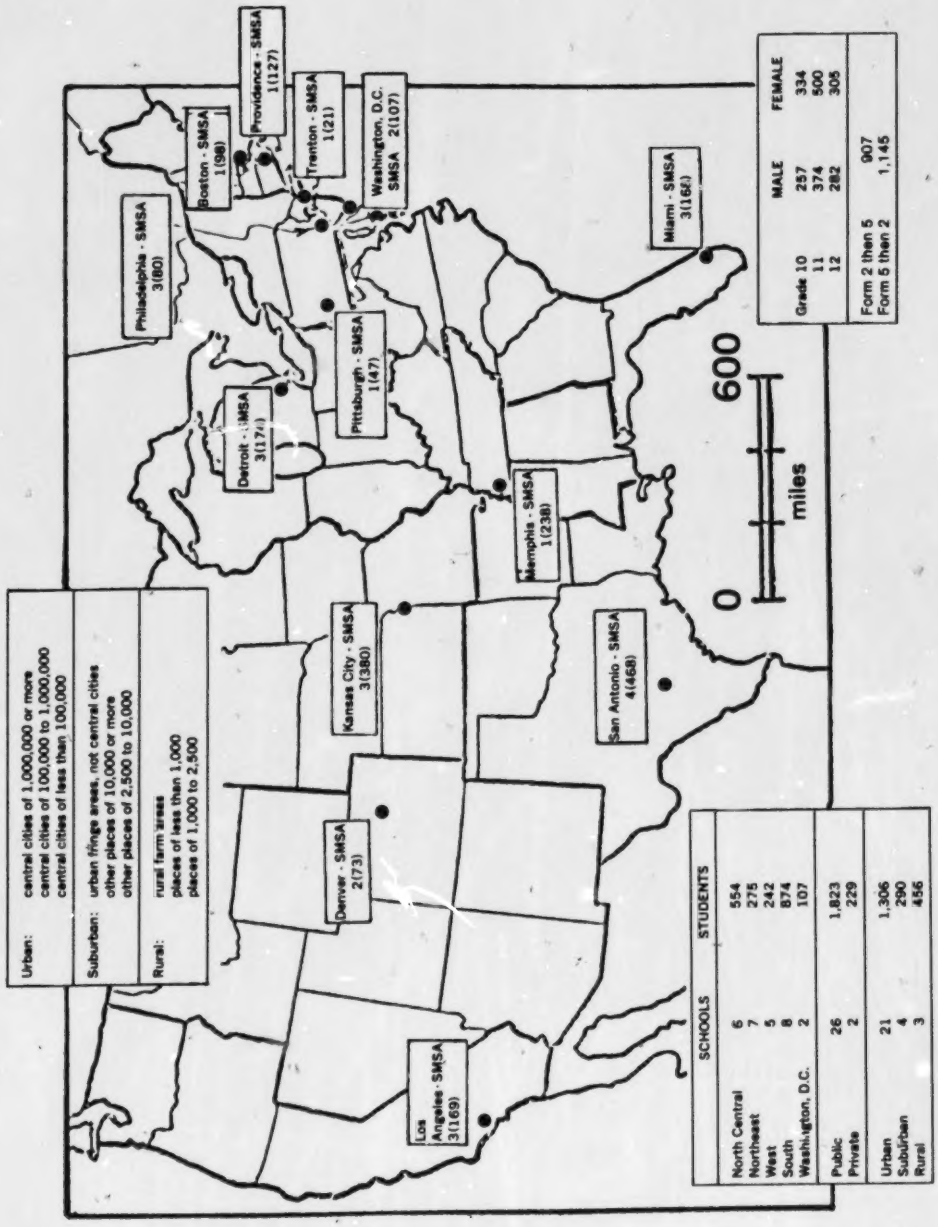
12 SUBTESTS IN ASVAB FORM 5 (con't)

11. **General Science (GS)**
    Multiple choice items about simple biology, chemistry, physics, physiology, and space science.

12. **General Information (GI)**
    Multiple choice questions on a variety of geographic, sports, military, and common knowledge topics.

Figure 1

Map Showing nationwide distribution of participating high schools and grade 10-12 students


Urban: central cities of 1,000,000 or more
central cities of 100,000 to 1,000,000
central cities of less than 100,000
Suburban: urban fringe areas, not central cities
other places of 10,000 or more
other places of 2,500 to 10,000
Rural: rural farm areas
places of less than 1,000
places of 1,000 to 2,500
Providence - SMSA 1(127)
Boston - SMSA 1(98)
Trenton - SMSA 1(21)
Washington, D.C. SMSA 2(107)
Philadelphia - SMSA 3(80)
Miami - SMSA 3(164)
Pittsburgh - SMSA 1(47)
Detroit - SMSA 3(174)
Memphis - SMSA 1(238)
Kansas City - SMSA 3(380)
San Antonio - SMSA 4(468)
Denver - SMSA 2(73)
Los Angeles - SMSA 3(169)
0
600
miles
MALE FEMALE
Grade 10 257 334
11 374 500
12 282 305
Form 2 then 5 907
Form 5 then 2 1,145
SCHOOLS STUDENTS
North Central 6 554
Northeast 7 275
West 5 242
South 8 874
Washington, D.C. 2 107
Public 26 1,823
Private 2 229
Urban 21 1,306
Suburban 4 290
Rural 3 456

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